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The Impact of Information and Communication Technology on Agricultural Systems and the Transition to Food Stability and Security (Case Study: Agricultural Jihad Organization, Khuzestan Province)

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Keywords: Information Technology, Agricultural Systems, Food Security, Sustainable Agriculture

Abstract

The purpose of this study was to investigate the role of information and communication technology in agricultural systems and the transition to food security and sustainability. From the perspective of the purpose, the present study is an applied research and from the perspective of data collection method is also a survey research. The statistical population of this study includes managers and experts and managers working in the Agricultural Jihad of Khuzestan province. According to statistics from the human resources unit of the organization there are 96 experts. Due to the limited statistical society census method was used. Questionnaire was used to measure research variables. The validity of the questionnaire was used by a panel of experts and Cronbach's alpha method was used to determine the reliability and Cronbach's alpha for the questionnaire was 0.798. Descriptive statistic methods used include mean, median and frequency percent and inferential statistical methods used Partial least squares method. The results show that information and communication technology has a positive and significant impact on agricultural systems. On the other hand, agricultural systems have an impact on food security and sustainable agriculture. Finally, it has been shown that information technology through agricultural systems enhances food security and achieves sustainable agricultural goals.

1. Introduction

Agriculture, as the most important way of providing human food, has drastically changed the structure and function of natural ecosystems. Human exploitation of natural resources is always unilateral and uncontrolled and exploitation of these resources is done without observing its protective aspects and only on the basis of providing short-term benefits .(Shahi & Kazemi, 2017). The application of Information and Communication Technology (ICT) across different sectors of the global economy has become a game changer in boosting work efficiency and productivity. The agriculture sector in the global economy is one of the industries experiencing tremendous ICT application in all spheres of its operations (Daum, 2020).

The agriculture sector has experienced a new technological revolution for the past ten years. Compared to a decade earlier, this new technological revolution has the potentials to respond to farmers' needs accurately and swiftly(Wolfert et al., 2017). Acquisition, acceptance and dissemination of new technologies and innovations are the main drivers of knowledge-based economic growth and development strategy in any country. Currently, Information and Communications Technology (ICT) is spread all over the world in economic, social and environmental dimensions. It has become one of the inherent dimensions of the movement of nations towards a justice-oriented society with a competitive, inclusive and sustainable economy. In addition, ICT has the potential to increase the dissemination of innovations and technologies in the socio-economic fields (World Bank, 2012; UNCTAD, 2011).

Observed that in recent years, ICTs had become one of the main driving tools used by farmers to manage the essential factors of production (land, labour, capital, and soil) in agriculture. ICT applications have the potential to identify and find solutions to some of the numerous problems faced in the field of agriculture, which includes prolonged droughts, pest and disease outbreaks, seasonality and spatial dispersion of farming; high transaction costs and information asymmetry (Anh et al., 2019). There has been a significant increase in ICT use over the last ten years, and today farmers' access to information markets is more important than ever. ICT can be effective in the agricultural sector in a variety of ways, as it can cover disadvantaged and inaccessible people (smallholder farmers, rural communities and urban suburbs) in almost all countries, both developed and underdeveloped (Chubchian, 2017).

The use of information and communication technologies in developed countries and emerging economies is one of the main ways to move towards sustainable development, so it makes sense for those countries that have more limited investment capacity to improve their technology infrastructure, the factors of successful technology lead to sustainable development being achieved. Lead transfer to achieving sustainable development. For this reason, the development of technology and, consequently, information and communication technology has always been important. One of the basic strategies for developing countries is strategic planning of information and communication technology to achieve sustainable agricultural goals (Jameson, 2018). Communication and information technologies can develop far-reaching economic activities and increase business in rural, underdeveloped areas by connecting farmers to markets. Prices of farm inputs (such as fertilizers, pesticides and seeds) as well as prices of machinery, tools and equipment, in addition to standards, quantity and quality of products, export and import laws, and the like, are important and information that should be provided to agricultural users (Elad et al., 2012).

Many people around the world believe that accelerating and modifying the process of knowledge and information exchange through information technology will play a very key role in achieving human resource development and sustainable development, and that a knowledge-based society is recognized as a model of sustainable development. Information technology can be financially valuable and has many applications in providing information for transmission and knowledge in order to share it among farmers, promoters and extension professionals and other stakeholders (Annor, 2006).

Food security is one of the aspects of human security and one of the indicators of development. It has always been emphasized by planners and policy makers in different countries of the world as one of the basic axes of development of human societies. The concept of food security is very broad and is determined by the interaction of a range of biological, economic, social, agricultural and physical factors. Food security refers to the access of all members of a community to adequate and healthy food for a healthy and active life at all stages of life (Abtahi & Bahmanipour, 2017).

The application of information and communication technology is current in all aspects of life, economic and social, so that today's organizations are in dire need of information technology. Without this technology, they will never be able to acquire new knowledge and skills. All economic and non-economic organizations and companies have become aware of the usefulness and necessity of using information technology (Bazrafshan Moghaddam & Amiri, 2017). Information technology (IT) as defined by the American Information Technology Association as: designed, developed, implemented, supported, or managed by computer-based information systems, especially software programs and computer hardware. In short, information technology deals with issues such as the use of computers and software to convert, store, protect, process, transmit and retrieve information safely and in a secure manner. Recently, a slight change has been made to the term to explicitly include the term telecommunications. So more and more people want to use the term Information communication technology or ICT for short (Domingues et al., 2016)

Information technology (IT), as defined by the American Information Technology Association, studies, designs, develops, implements, supports, or manages computer-based information systems, in particular computer software and hardware applications. In short, information technology deals with issues such as the use of computers and software to convert, store, protect, process, transmit and retrieve information in a secure and secure manner. Recently, a slight change has been made to this term so that the term clearly includes the scope of telecommunications. Therefore, more and more people want to use the term "information and communication technology" or ICT for short (Karba et al., 2016). Many integrate the concept of information technology with computers and informatics, while these are information technology tools that are not all that information technology offers (Hall, 2018).

Given the various definitions of information technology, there are two general perspectives on it. According to the first view, information technology is a subset of information systems. According to this view, information systems include hardware, software, databases and information technology. According to the second view, information technology is synonymous with information systems and may even have a broader meaning than the concept of information systems. According to the second view, information technology may include different information systems, users and their managers (Khadivar et al., 2017).

We believe that the key to future food security, food safety, and ecological sustainability lies in the use of customized data analytics by individual growers, agricultural workers, and food producers. For analytics to become the farm implements of the twenty-first century, new Information Technology (IT) developments that are accelerating e-commerce (e.g. cloud computing, machine learning, mobile client-server systems) must (1) be made inexpensive, be accessible to, and beneficial for, a vast diversity of the population, (2) address a number of disparate problems including increasing yields, conserving water, and ensuring soil and plant health, and (3) facilitate new sustainable agriculture science. Today smallholder agriculture and their communities (as opposed to the industrial-scale farming concerns) are strikingly underserved by modern IT (Krintz et al., 2016).

Up-to-date information as the most effective decision-making and planning tool can play an important role in laying the foundations for the optimal use of human and non-human resources and help the country to achieve the desired goals in agriculture. On the other hand, increasing the level of awareness, knowledge and abilities of farmers and agricultural operators will increase the quantity and quality of agricultural products. In addition to improving the living standards of villagers and reducing the gap between urban and rural life, the country imports agricultural and livestock products it does not need (Mollaei& Mirtalebi, 2012).

Information technology is considered as one of the most important axes of development in the world and many countries in the world have made the advancement of information technology as one of the most important infrastructures for their development. This technology can offer many abilities and capabilities to agricultural communities and is expected to be useful and effective in solving problems in the agricultural sector (Schreinemachers & Berger, 2011).

A system is a set of related activities and methods to achieve a specific goal. Since the 1970s, ecologists have shifted to a systemic approach to agriculture and, since 1980, the agricultural system has been recognized as a method. At present, due to the background of research and experiences in the field of agricultural systems, the approach of systems has shifted to a system that creates sustainable livelihoods (Norman, 2002).

In Norman's (2009) report, effective factors in designing agricultural systems are divided into two groups: technical factors, inputs and humans. In the technical group, factors are divided into two subgroups: biological factors (pests, animal species, and plant species) and physical factors. Climate (land, capital, water and water resources control, distance and market access) also in this study, two groups of external and internal factors have been considered effective under the subgroups of inputs and humans. External factors mentioned in this study include the business system of norms and beliefs, population density, potential factors, active job opportunities on the farm and internal factors such as family work, management ability, education and knowledge and cultivation goals.

Agriculture around the world has experienced many systems to produce the product, some of which overlap in terms of application, technique and technologies used. Meeting the nutritional needs of a growing population has been one of the goals of all systems used. Studies show that the most appropriate system is sustainable agriculture, which is one of the components of sustainable development in countries and can play a significant role in establishing food security in countries. This system, based on indigenous knowledge, tries to preserve the environment and create a dynamic economy (Modiri et al., 2015).

Information and communication systems can be used for the success of agricultural systems in achieving the goals of sustainable agriculture. With the development of information and communication technology and its spread to the field of agriculture, the issue of "agricultural information system" has been raised. If we consider sustainable agriculture as the ultimate goal of the agricultural sector it must be acknowledged that the agricultural information system is the foundation and the basis for achieving this goal. Sustainable agriculture is a long-term and ideal goal in both developed and developing countries. (Jameson, 2018).

Sustainable agricultural development is a model of development that protects land, water and plant and animal genetic resources, is environmentally sound without degradation, and is technically appropriate, economically viable and socially acceptable(Krintez et al. 2016).

The goal of sustainable agriculture is to increase the diversity of on-farm activities, along with increasing the links and processes between them. In sustainable agriculture, by-products or wastes from one component or activity become inputs to another component. As natural processes increasingly replace external inputs, the impact of external inputs on the environment decreases (Olson, 2017).

The goals of sustainable agriculture include such things as aligning agricultural activities with ecological processes; Applying appropriate technologies and adopting a correct and reasonable management in the process of agricultural production; Not using inputs and chemicals that are dangerous to the environment and human and animal health; Increasing agricultural production by exploiting the biological and genetic potential of different species; Wise use of resources and preservation of renewable and non-renewable resources, increasing the value of agricultural products, especially products of poor countries, reducing environmental impact in the agricultural sector (Plumecocq et al., 2018).

Food security is, indeed, the foundation of a developed society and constitutes the main component of health, efficiency and human learning (Santeramo, 2014; Garibaldi et al., 2017; Tehranchian et al., 2016; Golkar et al., 2018).

According to the definition by the World Food Summit in 1996, food security means that “all people, at all times, have physical, economic, and social access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (Soltani & Hesami Luei, 2012; Rashidi et al., 2014; Santeramo, 2014).

Food and nutrition is one of the basic dimensions of life, health and well-being of society. Food security is one of the criteria of human development and achieving it is one of the main goals of every country. Availability and supply of healthy and quality food, ease of access and purchasing power are the pillars of food security. Food security is provided when the per capita food basket of the family is properly selected and prepared (Gouvea et al., 2018). In recent years, the issue of food security and its guarantee in developing countries has become a major issue and a global goal (Pray & Umali-Deininger, 2016).

The Food and Agriculture Organization (FAO) said in a report that to feed the worlds 9 billion people by 2050, it must produce twice what it is today. To achieve this goal, obstacles such as limited agricultural land, water shortages, high energy prices, declining investment in agricultural research and increasing food waste must be considered. Thus, sustainable growth in the agricultural sector is a vital factor in feeding the world in the coming decades (Garibaldi et al., 2017).

We believe that the key to future food security, food safety, and environmental sustainability lies in the proper use and accurate analysis of custom data by individual producers, agricultural workers, and food producers (Krintez et al., 2016).

In their research, (Golkar et al., 2018) studied sustainable agriculture in arid regions. The results show that with the help of knowledge of plant breeding and plant genetics, through the application of new biotechnological tools, opportunities for the production of new food products have emerged to use these scientific achievements to enable the development of sustainable agriculture in semi-arid regions of the world.

In their research, (Soltani & Hesami Lui, 2012) studied entitled "Study and Recognition of Agricultural Industries and Food Security. The article tries to study food security and its effective factors and its inseparable relationship with the agricultural industry, because both of these cases are part of the country's macro-level development. The results showed that food security is endangered due to limited production resources (water, land, energy, etc.) on the one hand and population growth on the other. The challenges facing the agro-industry and food security need to be further explored. The results also showed that economic factors affect the development of agricultural infrastructure.

In their research, (Molaei & Mirtalebi, 2012) studied entitled Application of Information and Communication Technology in the Development of Agriculture and Rural Sector. In their study, they divided and studied the applications of technology in the sustainable development of the agricultural sector into three categories: 1 Knowledge and information required by users; 2 E-government, e-services and rural development; 3 Application of information technology in agriculture.

Susmita et al, (2016) has conducted a study entitled The Impacts of ICTs on Agricultural Production in BANGLADESH: A Study with Food Crops. The findings indicate that there is a production gap of the two category farmers and it could be minimized by using ICT tools more in farming of non-ICT service areas. A more organized approach to using ICT tools involving relevant knowledge based organizations is expected to bring better improvement to the total production system.

Jameson (2018) has conducted a study entitled The Impact of Agricultural Information System on Sustainable Agriculture. In this study, a questionnaire was used to collect data and structural equation modeling was used to analyze the data. The results of this study have shown that information technology infrastructure, economic factors and political factors have an impact on the development of agricultural infrastructure and the development of agricultural infrastructure has ultimately led to sustainability in the field of agriculture.

Hall (2018) in his study, concluded that information technology is one of the most important axes of development in the world and many countries in the world have considered the development of information technology as one of the most important infrastructures for their development. This technology is able to offer many abilities and capabilities to agricultural communities and is expected to be useful and effective in solving problems in the agricultural sector. Information in the field of agriculture and rural development is not only the effectiveness of other sources of production and development, (Return promotion factor) is considered as one of the main assets.

Amirzadeh et al. (2020); Gouvea et al., (2018); Pray & Umali-Deininger, (2016); Rashidi et al., (2014); Elad et al., (2012); Tan et al., (2012); Schreinemachers & Berger, (2011) in different studies concluded that information technology infrastructure and management factors have a significant role in the development of agricultural infrastructure. Also ICT have a positive and significant relationship with agricultural sustainability and food security, they have been able to increase food security efficiency.

Aim of Research

To investigate the role of information and communication technology in agricultural systems and the transition to food sustainability and security, the following sub-objectives were examined: a: Investigating the Impact of Information and Communication Technology on Agricultural Systems b: Investigating the Impact of Information and Communication Technology on Sustainable Agriculture. C: Investigating the Impact of Information and Communication Technology on Food Security d: Investigating the Impact of Agricultural Systems on Sustainable Agriculture. Investigating the Impact of Agricultural Systems on Food Security e: Investigating the Impact of Information and Communication Technology on Sustainable Agriculture through Agricultural Systems f: Investigating the Impact of Information and Communication Technology on Food Security through Agricultural Systems.According to the research background and generalization of the Jameson model (2018), the conceptual model of the research is shown in Figure 1.

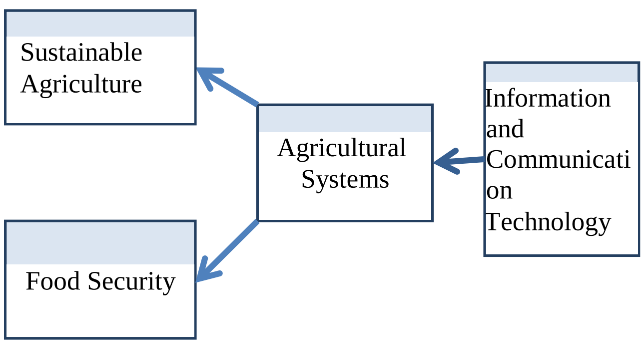

Figure 1. Conceptual research model

2. Materials and Methods

The aim of this study was to investigate the role of information and communication technology in agricultural systems and the transition to food sustainability and security. Therefore, in terms of purpose, it is an applied research and in terms of nature, it is a descriptive survey and cross-sectional description. The statistical population of this study included 96 managers and experts of Jihad Agricultural Organization of Khuzestan province in Iran. Due to the limited number of these people, the census method was used for sampling. The data collection tool was a questionnaire that includes 4 main dimensions which are: information technology, agricultural systems, food security, sustainable agriculture and one section included the demographic characteristics of the study population. To evaluate the validity of the questionnaire, a panel of experts was used. Cronbach's alpha coefficient was used to calculate the reliability of the questionnaire, the results of which are shown in Table 1. Smart PLS software has been used to calculate the combined reliability. Also, to calculate the convergent validity of the questionnaire, the mean of extracted variance (AVE) was calculated, the following relationships must be established:

$CR>0.7; AVE>0.5$ (1)

Table 1. SPSS software output for combined reliability and reliability and convergent validity of the questionnaire

Dimensions	Number of items	Cronbach's alpha	AVE	CR
IT	10	0.823	0.709	0.859
Agricultural Systems	7	0.853	0.829	0.829
Food security	6	0.712	0.751	0.785
Agricultural sustainability	7	0.672	0.630	0.729

Source: Research Findings

Descriptive statistical methods such as frequency distribution and mean tables have been used to examine and describe the general characteristics of the respondents. Variable validity was obtained from the research questionnaire using the measurement model (external model). The conceptual model of the research is then tested using the technique of least squares. The obtained data are analyzed using Smart PLS 2 statistical software. Hypotheses are tested and the relationship between variables is examined using the partial least squares technique or PLS. To fit the structural equation model, the criteria of coefficient of determination (R^2), redundancy and finally GOF statistics have been used.

3. Results and Discussion

3.1 Study of demographic characteristics

Descriptive results showed that 74 person of the statistical population (81%) were male and 17 person (19%) of the experts were female. In terms of education level, 16 people (18%) had associate degrees. 54 (59%) had a bachelor's degree and 21 (23%) of the statistical population also had a master's degree or higher. In terms of age, 23 (25%) of the experts are less than 35 years old. 39 (43%) were between 35 and 45 years old, and 29 (32%) were 45 years and older. The results also showed that 21 (23%) of the experts had less than 10 years of experience. 18 people (20%) had 10 to 15 years of experience, 30 people (33%) had 15 to 20 years of experience, 22 people (24%) had more than 20 years of experience. Other results are shown in Table 2.

Table 2. Demographic characteristics of the statistical population of the research

Gender	Friqency	Percent	cumulative frequency
male	74	81.32	81.32
female	17	18.68	100
Total	91	100	
Age			
<35	23	25.27	25.27
35-40	39	42.86	42.86
>45	29	31.87	100
Total	91	100	
Education			
Associate and less	16	17.58	17.58
Masters	54	59.34	59.34
Graduate	21	23.08	100
Total	91	100	
work experience			
<10	21	23.08	2308
10-15	18	19.78	19.78
15-20	30	32.97	32.97
>20	22	24.18	100
Total	91	100	

3.2 Descriptive analysis of research structures

Based on the findings of Table 3, it is clear that 91 correct data have been collected about the research structures. The mean of the data fluctuates between 3.2 and 4.5. Agricultural sustainability has the highest mean and the variable of agricultural systems has the smallest average. The range of data changes is less than 4 and food security has the lowest range of changes. The standard deviation of agricultural systems is higher than other variables and the standard deviation of agricultural sustainability is smaller than other variables.

Table 3. Descriptive analysis of research structures

Dimensions	IT	Agricultural Systems	Food security	Agricultural sustainability
number	91	91	91	91
mean	3.308	3.224	3.848	4.118
median	3.300	3.286	3.833	4.143
mode	3.200	3.286	3.667	4.286
Standard deviation	0.682	0.819	0.553	0.460
Variance	0.446	0.671	0.305	0.211
Variation range	3.200	3.429	2.500	2.286
minimum	1.700	1.429	2.500	2.714
maximum	4.900	4.857	5.000	5.000

3.3 Minimum minor squares PLS

The partial least squares technique has been used to identify the research structures. Finally, the general model of the research has been put to the test using the same technique. In the partial least squares technique, a few points are very important: Bootstrap or Jack Knife cross-cutting methods are used to examine the significance of the observed correlations. In this study, the self-management method is used, which gives the t-statistic. At the 5% error level, if the value of the bootstrap statistic t value is greater than 1.96, the observed correlations are significant. Structural validity examines the relationship between the questions of each structure (hidden variable) and the structure in question. The latent variables have been measured correctly and the construct validity has been used. The final results of construct validity are presented in the Table 4. (Hidden variable) and the structure in question. The latent variables have been measured correctly and the construct validity has been used. The final results of construct validity are presented in the table 4.

Table 4. Summary of the results of structural validity based on the external model of the research

Dimensions	Items	Factor load	t
IT	Q01	0.751	14.684
	Q02	0.789	14.900
	Q03	0.753	12.279
	Q04	0.456	4.990
	Q05	0.568	5.903
	Q06	0.433	3.389
	Q07	0.489	4.206
	Q08	0.571	5.244
	Q09	0.548	6.071
	Q10	0.735	13.190
Agricultural Systems	Q11	0.658	8.492
	Q12	0.805	20.392
	Q13	0.804	19.385
	Q14	0.820	23.574
	Q15	0.768	14.134
	Q16	0.837	23.598
	Q17	0.404	4.268
Food security	Q18	0.828	13.299
	Q19	0.831	14.009
	Q20	0.404	2.728
	Q21	0.772	15.383
	Q22	0.405	2.878

	Q23	0.366	2.422
Agricultural sustainability	Q24	0.439	2.721
	Q25	0.306	1.678
	Q26	0.446	2.411
	Q27	0.172	0.811
	Q28	0.807	10.882
	Q29	0.812	13.934
	Q30	0.560	3.992

Based on the validity results of the structure in the load table 4, the observation factor is greater than 0.3 in all cases, which indicates that there is a very good correlation between observable variables and hidden variables. Also based on the results of the measurement model listed in the bootstrap value table (t-statistic). In all cases, it is greater than the critical value of 1.96, which shows that the correlation between observable variables and hidden variables is significant. Therefore, it can be concluded that each structure has been measured correctly and considering the findings of this scale, we can test the research hypotheses.

3.4 Internal research model (test of hypotheses)

The relationship between the studied variables in each of the research hypotheses is tested based on a Causal structure with the PLS partial least squares technique. The general model of the research is shown in Figure 2. In this model, which is the output of Smart PLS software a summary of the results related to the standard operating load of the variables is presented. The t-statistic and the bootstrap value for measuring the significance of the relationships were also shown in Figure 3. In order to facilitate the drawing of the model for the variables, an acronym is given, which is given in Table 5, respectively:

Table 5. Research structures and symbols used in the research model

Question number	Number of items	symbol	Main structures
1-10	10	IT	IT
11-17	7	AS	Agricultural Systems
18-23	6	FS	Food security
24-30	7	SA	Agricultural sustainability

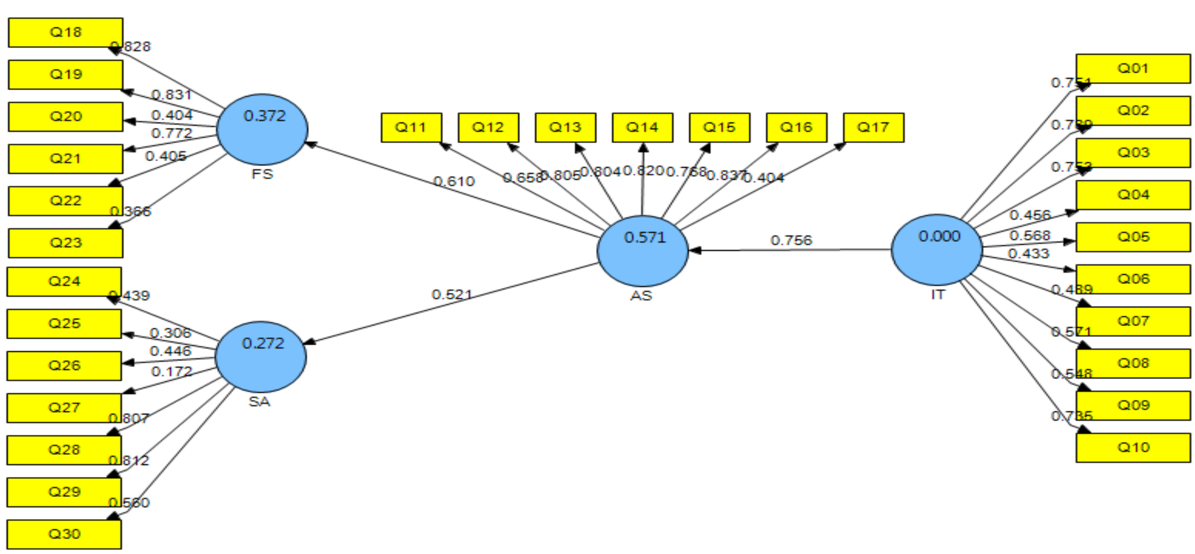

Figure 2. Partial least squares technique Conceptual model of research

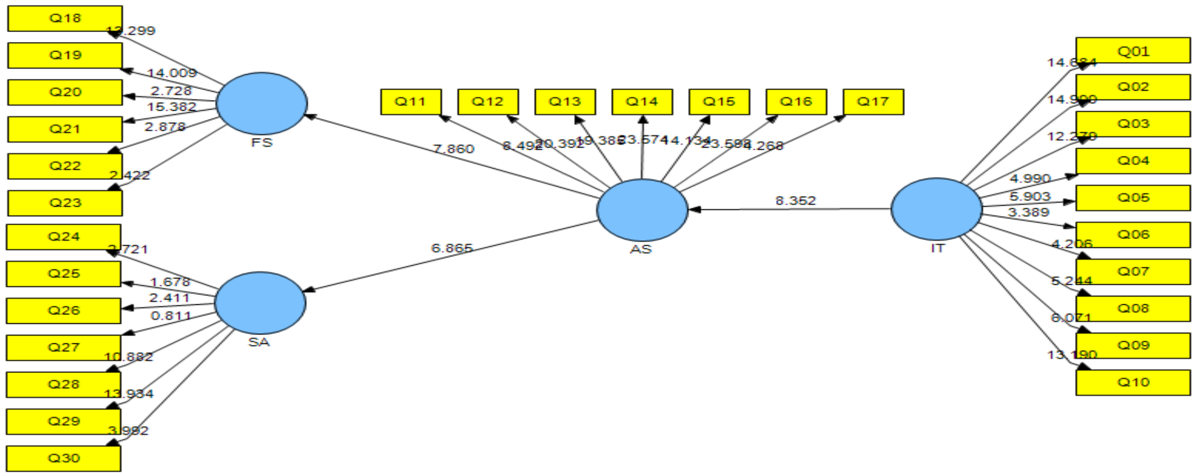

Figure 3. Conceptual model of research (amount of statistics with bootstraping)

After ensuring the accuracy of the measurement of research structures, it is possible to test the research hypotheses using the relationships of these structures. As shown in Table 6, information technology has a positive and significant effect on agricultural systems and food security and agricultural sustainability according to the factor load and the value of t-statistic obtained. Also, agricultural systems as a mediating variable have a positive and significant effect on food security and agricultural sustainability according to the factor load and the value of t-statistic obtained.

Table 6. Summary of results of hypotheses test

Result	t	Factor load	Dependent Variable	Independent variable	Hypotheses
Confirmation	8.352	0.756	Agricultural systems	IT	Hypothese1
Confirmation	6.759	0.509	Food Security	IT	Hypothese2
Confirmation	5.754	0.410	Agricultural Sustainability	IT	Hypothese3
Confirmation	7.860	0.610	Food Security	Agricultural systems	Hypothese4
Confirmation	6.845	0.521	Agricultural Sustainability	Agricultural systems	Hypothese5

Investigating the mediating role of agricultural systems

In general, if the independent variable is represented by X, the dependent variable by Y, and the mediating variable by M, the mediating variable M is a variable that indirectly affects the direction and intensity of the effect of the independent variable X on the dependent variable Y. We must distinguish between direct effect and indirect effect:

Direct effect: effect of independent variable on dependent

Total effect: direct effect of indirect effect

Indirect effect: effect of the independent variable on the dependent one through the mediating variable studying the mediating effect.

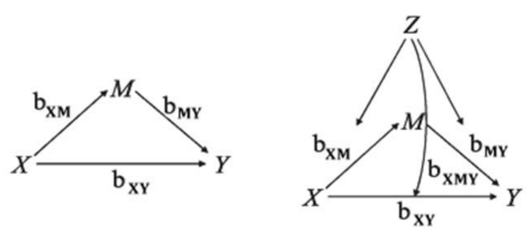

Figure 4. The role of independent, mediating, and dependent variables (Edwards, 2007)

In each of the previous hypotheses, it was found that "information and communication technology" affects "agricultural systems". On the other hand, "agricultural systems" affect "food security" and "sustainable agriculture". Therefore, the impact of information and communication technology on sustainable food security and agriculture should also be assessed.

As a result:

Indirect Impact of Information and Communication Technology on Food Security with the Mediating Role of Agricultural Systems = Impact of Information and Communication Technology on Agricultural Systems × Impact of Agricultural Systems on Food Security is assessed with regard to agricultural systems: 0.765 × 0.610 = 0.461

Indirect Impact of Information and Communication Technology on Food Security with the Mediating Role of Agricultural Systems = Impact of Information and Communication Technology on Agricultural Systems × Impact of Agricultural Systems on Food Security.

0.756 × 0.521 = 0.394

Sobel statistic is used to test the significance of indirect effects caused by an intermediate variable

$$Z = \frac{\mathbf{a \times b}}{\sqrt{\mathbf{b}^2 s_a^2 + \mathbf{a}^2 s_b^2}} \quad (2)$$

a: Path coefficient between independent and mediator variables

b: Path coefficient between mediator and dependent variables

Sa: Standard error of independent and intermediate variable path

Sb: Standard error of intermediate and dependent variable path

$$Z_2 = \frac{0.756 \times 0.72}{\sqrt{0.72^2 0.049^2 + 0.756^2 0.182^2}} = 2.815 \quad (3)$$

$$Z_1 = \frac{0.756 \times 0.610}{\sqrt{0.610^2 0.154^2 + 0.756^2 0.133^2}} = 3.351 \quad (4)$$

The value of test statistics using Sobel test was 3.351 and 2.815, respectively, which is greater than 1.96. Therefore, it can be said that the hypothesis of the mediating role of the variable of agricultural systems is accepted. The results of the study of the direct relationship between the model variables are given in the Table7.

Table 7: Summary of the results of the indirect effect of model variables

t	Indirect effect	Dependent Variable	Mediator Variable	Independent variable
3.351	0.756 × 0.610 = 0.461	Food Security	Agricultural systems	IT
2.815	0.756 × 0.521 = 0.394	Agricultural Sustainability		IT

Model fit evaluation

The coefficient of determination (R^2) is a measure that indicates the amount of change in each of the dependent variables of the model, which is explained by independent variables.

According to the table 8, the value of R^2 is the coefficient of determination of endogenous structures of the research model. The value of detection coefficient of agricultural systems is reported to be 0.571, which is an acceptable value. The results are shown in Table 8.

Table 8. Determination coefficient of endogenous structures of the model

R^2	Durable variable
0.571	Agricultural systems
0.372	Food Security
0.272	Agricultural Sustainability

Another important indicator for model fit in the technique is the minimum partial squares of the GOF index. This index is calculated using the square root of "average index R ²" and "mean redundancy indices":

$$\text{GoF} = \sqrt[2]{\overline{(R^2)} \times \overline{(\text{Communality})}} \quad (5)$$

Therefore, the goodness of fit in this study is equal to:

$$\text{GOF} = \sqrt[2]{0.405 \times 0.384} = 0.395$$

The GOF index is 0.395, which indicates that the model has a good fit.

Discussion

The standard factor load of the effect of information technology on agricultural systems in the study was 0.801, which is consistent with the results of the present study. Results of the study by Elad et al., (2012) are also consistent with these results. The results of the second hypothesis showed that agricultural systems have a positive and significant effect on food security. This result is in line with the results of Sharafizadeh and Hemmati (2014), and Pray and Umali-Deininger (2016) researches. The results of the third hypothesis showed that agricultural systems have a positive and significant effect on sustainable agriculture. This result is consistent with the results of Jameson (2018) research. The results of the fourth hypothesis showed that agricultural systems act as an intermediary variable between information and communication technology and sustainable agriculture as well as food security. These results are consistent with the research (Shuang, 2014), (Li et al., 2001), and Rashidi et al., (2014).

4. Conclusion and Recommendations

Considering the positive and significant effect of information technology on agricultural systems, it is proposed to strengthen management information systems in agriculture and to develop e-commerce information technology in the field of agriculture.

It is also suggested that by creating a database for agriculture and creating geographic information systems and a global positioning system, farmers can be helped to achieve their micro and macro goals.

Given the positive and significant impact of agricultural systems on food security, it is suggested to use technological innovations in the field of information as well as the development of widely used technologies in agriculture and food security to try to be effective and efficient on the eve of the third millennium. Production in this area increased and moved towards food security**.**

Considering the positive and significant effect of using information and communication technology through agricultural systems on sustainable agriculture, it is suggested that farmers become familiar with new systems through courses and workshops and keep up with the advancement of technology, their information and use of technologies; also, to progress.

Given the positive and significant impact of information and communication technology through agricultural systems on food security, efforts to increase efficiency and productivity and optimize agricultural production processes, food security are inevitable. To reach this, it is necessary to achieve agricultural and rural development. Therefore, it is suggested that researchers at different levels, especially in the field of agriculture and production, investigate the relationship between research and production, and using information technology try to remove existing barriers.

It is also suggested that efforts to move from a linear and behavioral approach to development and a systemic approach to the agricultural production system be viewed as a whole. Considering the growth of required inputs and facilities, and in line with related global developments, the growth of technology, a more comprehensive concept in the form of quantitative and qualitative development of knowledge and information should be considered as the focus of development activities.

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